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## PILOT TEST OF THE WESTERN SPRUCE BUDWORM SURVEY SYSTEM IN THE LAKE STATES, FIRST PROGRESS REPORT

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### INTRODUCTION

Eastern spruce budworm Choristoneura fumiferana (Freeman) populations and damage are monitored by several different methods in the eastern United States and Canada. Budworm damage is expressed as a level of defoliation in relation to numbers of egg masses per sample unit, as egg masses in sequential sampling techniques (Waters 1955). These methods are then modified to meet local conditions or traditions.

Canadians use an 18-inch branch tip or a whole branch as a sample unit to estimate egg mass density per current shoot or per square foot of foliage (Miller et al. 1972). Another Canadian method is the National Research Council Canada (NRCC) tree vigor index (Dorais and Hardy 1976) based on the number and condition of terminal and penultimate buds and defoliation. Maine uses an 18-inch branch sample to sample egg masses per 100 in<sup>2</sup> foliage. Vermont, New Hampshire, and New York use a 15-inch branch for sequential sampling techniques.

With all these systems, expressions of the same budworm population level appear different. To ease this confusion a standardized technique is being evaluated.

The same confusion exists in the western United States in monitoring western spruce budworm, C. occidentalis (Freeman). In 1976 a standard technique, the western spruce budworm egg mass defoliation survey (Grimble 1977) was proposed for evaluation in several western regions.

This report reviews objectives, progress, and first year results on the evaluation to standardize an eastern spruce budworm survey method in the Lake States by the procedures outlined in the western spruce budworm survey.

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## OBJECTIVES

The main objective is to evaluate the western spruce budworm egg mass-defoliation survey procedure and prediction models for applicability to spruce budworm infestations on balsam fir in the Lake States. Other objectives are to:

1. compare defoliation prediction results of the western spruce budworm survey procedure with the 15-inch sample unit system currently used by the USDA Forest Service in the Lake States
2. determine variance levels in spruce budworm eggs/egg mass between geographical areas within the Lake States
3. determine if numbers of eggs/m<sup>2</sup> foliage or egg/masses/m<sup>2</sup> foliage provide the most accurate estimating parameter for expected defoliation
4. determine whether field or laboratory foliage examination is more accurate for egg masses/sample unit

## METHODS

### A. Plot Location

Data was collected from fir stands in the Superior National Forest and Cloquet State Forest in Minnesota, the Nicolet National Forest in Wisconsin, and the Ottawa and Hiawatha National Forests in Michigan.

### B. Egg Mass Sampling

#### 1. Stands

Entomological unit (balsam fir stand): The smallest area that a defoliation prediction model was made for was a balsam fir stand, at least 50 percent dominant and codominant fir trees. The stands varied in size from 15 to 150 acres which is representative of fir stands in the Lake States.

#### 2. Plots

Each stand sampled has two to five plots. The first plot in a stand was selected randomly near an access



road. Additional plots were placed in a straight line three to five chains apart into the stand. Compass direction from a known point and distance between the plots was recorded on forest maps for relocation in successive annual surveys.

### 3. Trees

Three codominant balsam fir, 25 to 60 feet tall, were sampled in each plot. Sampled trees were numbered permanently with paint and flagged for relocation. No dead or totally defoliated trees were selected.

### 4. Sample Unit

#### Foliated area

Two branches were cut from opposite sides on the midcrown of each sample tree. Sample branches were then cut to 70cm, 27 inches, for uniformity in determining foliated area. The formula for the area of a triangle was used to determine the foliated area:

$$\text{Length} \times \text{Width} - 10,000 = M^2$$

#### Egg mass

Each branch was examined thoroughly in the field for current year egg masses. The first branch of each sample tree examined was then cut into short pieces and placed in a paper bag for transport to the laboratory. This branch was examined under black light at the laboratory to verify the field egg mass count. The number of eggs/egg mass was estimated according to the method developed by Acciavatti and Jennings (1976).

#### Defoliation estimate

An estimate of the 1977 defoliation of current (1977) foliage was made on the same two branches used for the egg mass counts and on two additional branches from each tree at each plot. Defoliation was estimated in units of 25 percent. The estimate was based on a count of the first 25 current shoot tips starting at the terminal end of the sample branch. Each branch rating was totaled and the average computed for each branch and then for each plot with the following formula:



$\frac{\text{Total of rating/branch}}{25} - 12.5 = \text{Plot defoliation rating}$

(12.5 is subtracted to reach the midpoint between two rating levels.)

The defoliation classes are:

<u>Percent defoliation</u>	<u>Class</u>
0-25	1
26-50	2
51-75	3
76-100	4

### ANALYSIS

Some preliminary data analyses were made to provide information on those objectives that could be answered with a single sampling and to estimate the numbers of additional plots necessary to reach the 20 percent precision prediction level specified in the western spruce budworm program.

### RESULTS

#### 1. Field vs. laboratory counts

No significant difference existed in the number of egg masses found on sample branches, compared to each method (0.05 level (Table 1)).

#### 2. Eggs/egg mass

No significant difference existed in the average number of eggs/egg mass between sampled locations when using balsam fir as the host (0.05 level).

There was a significant difference (0.05 level) in the number of eggs/egg mass between balsam fir (Cloquet State Forest) and white spruce (Nicolet National Forest) samples. Two reasons for this may be: 1) the small sample area used or 2) difference in needle characteristics of the two species affecting the egg laying pattern (Table 2).



### 3. Summary of egg mass survey

Based on the results of the 1977 egg mass survey, the sampling intensity/National Forest was not sufficient to approach the desired 20 percent precision of standard error within the egg mass sample mean.<sup>2</sup> This was mainly due to the low numbers of egg masses/M<sup>2</sup> of foliage sampled. Table 3 lists the number of additional samples required to reach the precision goal.

Table 1: Laboratory black light egg mass counts compared to field counts/ sample branch, spruce budworm sampling evaluation, Lake States, 1977

Method	No. of branches sampled	No. egg masses found	No. egg masses/ branch	S. D.	S. E.
Lab count	81	125	1.54	4.48	0.498
Field Count	81	125	1.51	4.40	0.489

Table 2: Spruce budworm eggs/egg mass at different locations, spruce budworm sampling evaluation, Lake States, 1977

Forest	State	Tree species	No. egg masses	No. eggs/ egg mass	S. D.	S. E.
Superior NF	MN	Balsam fir	12	20.57	7.76	2.24
Colquet SF*	MN	Balsam fir	23	24.68	9.19	1.92
Ottawa SF	MI	Balsam fir	76	21.16	9.95	1.14
Hiawatha NF	MI	Balsam fir	32	24.31	8.82	1.56
Nicolet NF	WI	Balsam fir	77	19.51	8.46	0.96
Nicolet NF *	WI	White spruce	15	15.89	6.92	1.79

\*Significantly different pairs of No. eggs/egg mass at 0.05 level:  
Cloquet SF - Balsam fir; Nicolet NF - White spruce



Table 3. Summary statistics for spruce budworm egg-mass sampling of balsam fir, Lake States, 1977

Forest	E. U. <sup>a/</sup> stands	Plots	Average no. masses/ m <sup>2</sup> ( $\bar{x}$ )	Range: No. of masses/m <sup>2</sup>	S. E.	S. D.	Relative SE as a percent of ( $\bar{x}$ )	Optimum sample size <sup>b/</sup>	Additional samples needed
Superior NF	14	49	0.68	0-5.5	0.19	1.31	27.7	95	46
Virginia RD	1	4	0.96	0-2.9	0.68	1.37	70.9	51	47
Aurora RD	3	13	2.11	0-5.5	0.48	1.72	22.7	17	4
LaCroix RD	1	5	0.08	0-0.4	0.08	0.19	100.0	142	137
Gunflint RD	4	12	0.12	0-1.4	0.12	0.40	100.0	293	281
Tofte RD	5	15	0.00	-	-	-	-	-	-
Cloquet SF	2	9	17.91	0-59.8	6.72	20.17	37.5	32	23
Ottawa NF	7	21	11.86	0-66.1	3.22	15.80	27.2	45	24
Watersmeet RD	3	9	10.71	0-35.1	4.19	12.57	39.1	35	26
Iron River RD	2	6	22.85	6.2-66.1	6.27	18.82	27.4	17	11
Ontonagon RD	1	3	2.70	0-4.3	1.36	2.35	50.3	19	16
Bergland RD	1	3	0.60	0-1.1	0.32	0.56	53.3	22	19
Nicolet NF	1								
Eagle River RD	1	3	44.80	37.8-54.6	5.05	8.74	11.3	1	0
Hiawatha NF	3								
Rapid River RD	3	7	16.02	0-46.9	6.88	18.22	49.9	33	26

<sup>a/</sup> Entomological unit<sup>b/</sup> Desired precision is 20 percent



## RECOMMENDATIONS

1. Continue sampling procedures in established plots through 1979 egg mass survey and 1980 defoliation period.
2. Delete Nicolet National Forest from the survey to allow time to add stands and plots on the other three forests to approach the required number to reach specified precision level in the egg mass survey. Add stands and plots on those forests districts showing moderate to high levels of egg mass population in the 1977 survey.
3. Insert sampling procedure using a 15-inch branch sample for comparison of efficiency and accuracy with the western sample procedure.
4. Count egg masses and defoliation in the field at the time of sampling.
5. Resample eggs per egg mass to confirm the 1977 findings for each geographical area.

## REFERENCES

- Acciavatti, R. E., and D. F. Jennings.  
1976. Locating western spruce budworm egg masses with ultraviolet light. U. S. Dep. of Agric. For. Serv. Note RM 313. 3p.
- Dorais, L. G., and Y. J. Hardy.  
1976. Methods de valuation de la protection accordee au sapin baumier par les pulverisation aeriennes contre la tordeuse des bourgions de l'epinette. Can. For. 6:(1):86-92.
- Fettes, J. J.  
1950. Investigations of sampling techniques for population studies of the spruce budworm on balsam fir in Ontario. For. Insect Lab., Sault Ste. Marie, Ont., Annu. Tech. Rep.
- Miller, C. A., E. G. Kettela, and G. A. McDougall.  
1972. Sampling methods in spruce budworm surveys. Env. Can. For. Serv., Bi-mon. Res. Notes 28:31.
- Waters, W. E.  
1955. Sequential sampling in forest insect surveys. For. Sci. 1:68-79.